MONTANA
DEPARTMENT
OF
TRANSPORTATION



GUIDELINES FOR

WORK ZONE SAFETY

Guidelines for Municipalities
l Maintenance

ber 1994

TE228
.G85
1994

Table of Contents

Introduction 2
Traffic Control Devices 2
- Signs 2
- Spacing of Advance Warning Signs 3
- Channelizing Devices 4,5
- Guidelines for Length of Buffer Space 6
- Lighting Devices 6
- Arrow Display 7

Five Parts of a Traffic Control Zone 8
Taper Length Criteria For Work Zones 9
Table for "L" 10
Definitions 11
Typical Application Diagrams 12
- Work Beyond the Shoulder 13
- Mobile Operation on Shoulder 14
- Shoulder Work With Minor Encroachment 15
- Work in Travel Lane on Minor Urban Street 16
- Lane Closure on Minor Street 17
- Lane Closure on a Two-Lane Road Using Flaggers 18
- Temporary Road Closure 19
- Work in Center of Low-Volume, Low-Speed Road 20
- Center Turn Lane Closed on a Three-Lane, Two-Way Road 21
- Mobile Operations on Two-Lane Road 22
- Lane Closure on a Divided Highway 23
- Lane Closure in Advance of Intersection 24
- Lane Closure in Advance of Intersection 25
- Lane Closure Beyond Intersection 26
- Lane Closure Beyond Intersection 27
- Closure in Center of Intersection 28

Flagging Procedures 29
Liability 30
Supervisor's Checklist 31
Acknowledgments 32

Introduction

The purpose of this handbook is to present basic guidelines for work zone traffic control with particular emphasis on short-term work sites on roads and streets in rural and small urban areas. These requirements apply to maintenance, municipalities, utility companies, their consulting engineers and contractors.

This handbook presents information and gives examples of typical traffic control applications for two-lane and multi-lane work zones. This information is intended to illustrate the principles of proper work zone traffic control, but is not a standard. Part VI of the MUTCD contains the national standards for work zone traffic control.

Traffic Control Devices

The following are four types of traffic control devices used in work zone traffic control:

- Signs
- Channelizing Devices
- Lighting Devices
- Pavement Markings

Signs

Signs used in work zone traffic control are classified as regulatory, guide, or warning. Regulatory signs impose legal restrictions and may not be used without permission. Montana Department of Transportation Maintenance is permitted by Montana law to use the 35 M.P.H. regulatory signs. Guide signs commonly show destinations, directions, and distances. Warning signs give notice of conditions of potential conflict to traffic.

Spacing of Advance Warning Signs

ROAD TYPE	DISTANCE BETWEEN SIGNS (ft)		
	FIRST SIGN FROM TAPER	SECOND SIGN	THIRD SIGN
urban (low speed)	200	200	200
urban (high speed)	350	350	350
rural	500	500	500
expressway / freeway	1000	1600	2600

Warning Signs — Construction and maintenance warning signs are used extensively in street and highway work zones. These signs are normally diamond shaped, having a black symbol or message on an orange background. As a general rule, these signs are located on the right-hand side of the street or highway.

Size — The standard size for advance warning signs in work zones is generally 48 inches by 48 inches. Where speeds and volumes are relatively low (most of Montana's primary routes fall under this category), a minimum size of 36 inches by 36 inches may be used (see Part VI of the MUTCD for specific sign sizes).

Mounting — Standards for height and lateral clearance of roadside signs are included in Part VI of the MUTCD. Signs mounted on barricades or temporary supports may be at lower heights, but the bottom of the sign shall be not less than one foot above the pavement elevation. Higher mounting heights are, however, desirable.

Illumination and Retroreflectorization — All signs used during the hours of darkness shall be made of retroreflective material or illuminated. (Street or highway lighting is not regarded as meeting the requirements for sign illumination.)

Channelizing Devices



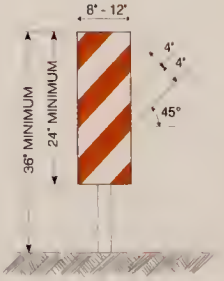
TYPE I BARRICADE



DRUM



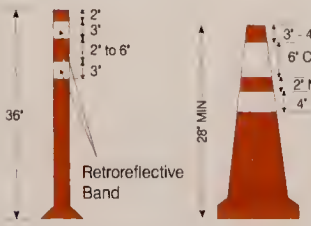
TYPE II BARRICADE



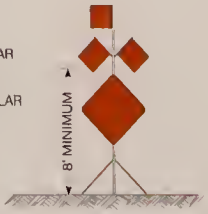
VERTICAL PANEL



TYPE III BARRICADE



CONES



HIGH LEVEL
WARNING DEVICE

Note: Flashing or steady burn warning lights should be used on barricades, panels, and drums as needed.

Channelizing Devices

Channelizing devices are used to warn and alert drivers of hazards in work zones, protect workers, and guide and direct drivers past the hazards. Channelizing devices include cones, vertical panels, drums, barricades, and barriers. The most common channelizing device used in temporary work zones is the traffic cone.

Traffic Cones — Traffic cones must be orange in color and a minimum of 28 inches in height. Cones used at night shall be retroreflectorized.

Spacing — Channelizing devices should be spaced so that they make it apparent that the roadway or work area is closed to traffic. There are several rules of thumb that can be used to guide you in the proper spacing of channelizing devices.

1. The maximum spacing between devices in a taper should be a distance, in feet, which is approximately equal to the speed limit in MPH. For example, if the taper is on a street with a 35 MPH speed limit, the devices should be spaced at about 35 feet.
2. All tapers should be made up of a least five (5) channelizing devices.
3. The spacing between devices in a buffer or work area may be up to a distance, in feet, of two (2) times the speed limit in MPH. For example, if the street has a speed limit of 35 MPH, the devices in the buffer and work area may be spaced up to 70 feet.
4. In urban areas, shorter spacings between devices in the buffer and work areas may be more appropriate. For example, the spacing used in tapers could also be used in buffers and work areas.

Guidelines for Length of Longitudinal Buffer Space

Speed (mph)	Length (feet)
20	35
25	55
30	85
35	120
40	170
45	220
50	280
55	335
60	415
65	485

Lighting Devices

Lighting devices for short-term construction and maintenance work zones are designed to supplement the signs and channelizing devices used in these zones. Typical lighting devices include warning lights, flashing vehicle lights, and flashing arrow panels. Warning lights shall have a minimum mounting height of 30 inches to the bottom of the lens.

Warning Lights — the principal types and use of warning lights are:

1. Low Intensity Flashing Lights (Type A) — Used to warn of an isolated hazardous area.
2. High Intensity Flashing Lights (Type B) — Normally mounted on advanced warning signs to draw attention to a hazard both day and night.
3. Low Intensity Steady-Burn Lights (Type C) — Used in a series to delineate the edge of the travelway and channelize traffic.

4. Flood Lights — When nighttime work is required, flood lights should be used to illuminate flagger stations, equipment crossings, and other areas where existing light is not adequate.
   SEE MUTCD CHAPTER 6 FOR RESTRICTIONS!!!

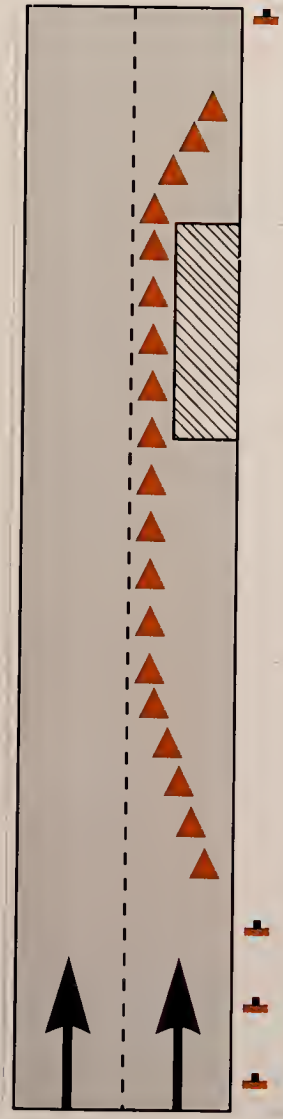
Arrow Display

	Minimum Size	Minimum Number of Lamps	Minimum Legibility Distance
Urban	24" x 48"	12	1/2 Mile
Standard	30" x 60"	13	3/4 Mile
Expressway/ Freeway	48" x 96"	15	1 Mile

An arrow display shall not be used on a two-lane, two-way roadway for temporary one-lane operation.

Five Parts of a Traffic Control Zone

The traffic control zone is the distance between the first advance warning sign and the point beyond the work area where traffic is no longer affected. Below is a diagram showing the five parts of a traffic control zone.



TERMINATION AREA
lets traffic resume
normal driving

WORK AREA

BUFFER AREA
provides protection for
traffic and workers

TRANSITION AREA
moves traffic out
of its normal path

ADVANCED WARNING AREA
tells traffic what
to expect ahead

Taper Length Criteria For Work Zones

There are five types of tapers used in work zone traffic control. The length of each type of taper is based on formulas using the speed of the traffic and the width of the offset (or lane width). The following are the five types of tapers and their lengths.

Type of Taper	Taper Length
Merging Taper	L Minimum
Shifting Taper	1/2 L Minimum
Shoulder Taper	1/3 L Minimum
Two-Way Traffic Taper	100 Feet Maximum
Downstream Tapers (use is optional)	100 Feet Per Lane

Formulas for L

Speed Limit	Formula
40 MPH or Less	$L = \frac{WS^2}{60}$
45 MPH or Greater	L = WxS

where,

- L = Taper Length in feet
- W = Width of offset in feet
- S = Posted speed, the off-peak 85th percentile speed prior to work starting, or the anticipated operating speed in MPH.

Table for "L" (Taper Length)

	LANE WIDTH		
Speed	**10'**	**11'**	**12'**
30	150	165	180
35	204	225	245
40	267	293	320
45	450	495	540
50	500	550	600
55	550	605	660
60	600	660	720
65	650	715	780

Definitions

The following are several important definitions for terms used in these guidelines. These definitions were developed to aid the supervisor at the job site in determining the appropriate traffic control for the existing street or highway conditions. If the traffic conditions change during the course of the work, then the traffic control must change also.

Low Speed — As a general rule, a low speed road can be considered one on which the posted speed limit is 35 miles per hour (MPH) or less.

Low Volume — As a general rule, a low volume road can be considered one on which the average daily traffic volume (ADT) does not exceed 500 vehicles per day. If the traffic volumes are not known, the following rule of thumb can be used to determine if the road can be treated as low volume for the purposes of installing work zone traffic control.

Rule of Thumb — Count the number of vehicles that pass a single reference point over a five (5) minute period. If not more than three vehicles pass the reference point in that period, then the road can be considered low volume for the purpose of installing work zone traffic control.

In addition, special attention should be given to local, nearby facilities, such as schools, manufacturing plants, etc., that cause special traffic generation. Consideration should also be given as to whether the work zone location is subject to peak hour traffic increases. Peak hours are usually 7-9 a.m. and 4-6 p.m., and will vary in different areas.

Urban Street — This is generally a two-lane, low speed, city street located inside a municipality's corporate limit. A subdivision street that is not within a municipality's corporate limits but has the same urban characteristics may also be classified as an urban street.

Minor Urban Street — A low volume, urban street.

Typical Application Diagrams

The diagrams on the following pages represent examples of the application of principles and procedures for safe and efficient traffic control in work zones but are not intended to be standards. It is not possible to include illustrations to cover every situation which will require work area protection. These typical layouts are not intended as a substitute for engineering judgment and should be altered to fit the conditions of a particular site.

In addition to the typical diagrams, tables are presented which provide information on taper lengths and buffer spaces. The information presented in these diagrams and tables are minimums for standard highway conditions. For urban conditions, shorter spacings may be used and are listed in parentheses in the typical diagrams. Expressway and freeway conditions will require longer distances. For further information, refer to Part VI of the MUTCD; it is the national standard for work zone traffic control. For specific interpretation, contact the MDT District Traffic Engineer.

Legend


Channelizing Device


Direction of Travel


Flagger


Portable Sign


Flashing Arrow Panel


Flashing Vehicle Light

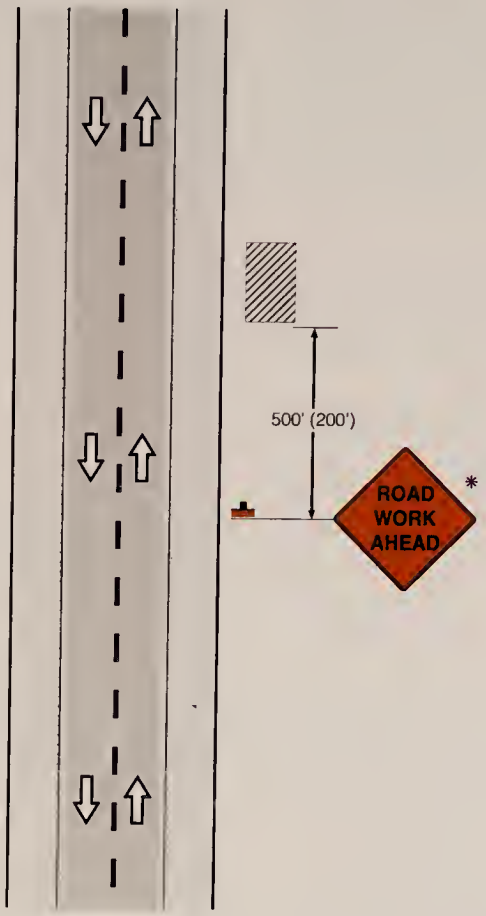

High Level Warning Device


Work Area


Work Vehicle


Warning Sign

Work Beyond the Shoulder

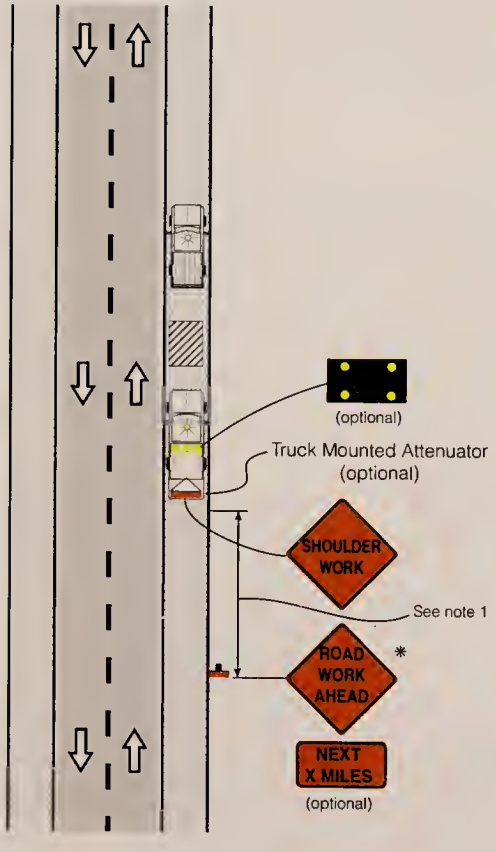


NOTES:

1. The signs illustrated in this figure are not required if the work space is behind a barrier, more than two feet behind the curb, or 15 feet or more from the edge of any roadway.
2. The ROAD WORK AHEAD sign may be replaced with other appropriate signs, such as the SHOULDER WORK sign. The SHOULDER WORK sign may be used for work adjacent to the shoulder.
3. If the work space is in the median of a divided highway, an advance warning sign should also be placed on the left side of the directional roadway.
4. For short-term, short-duration, or mobile operations, all signs and channelizing devices may be eliminated if a vehicle with an activated flashing or revolving yellow light is used.

***For Utility Operations Use: "UTILITY WORK AHEAD"**

Mobile Operation on Shoulder

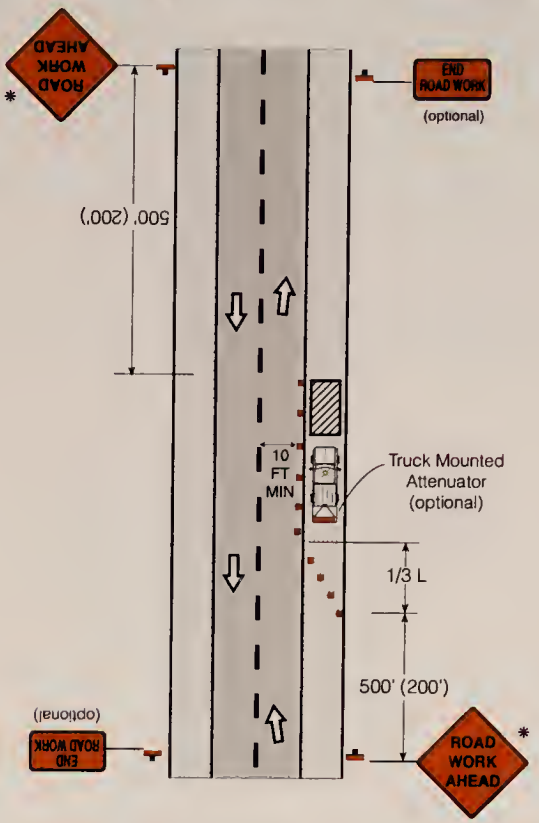


NOTES:

1. In situations where multiple work locations in a limited distance make it practicable to place stationary signs, the maximum spacing for the advance warning sign is five miles in advance of the work.
2. The length of activity area sign may be used as the stationary advance warning sign if the work locations occur over a distance of more than two miles.
3. Warning signs are not required if the work vehicle displays a flashing or revolving yellow light, if the distance between work locations is one mile or more, and if the work vehicle travels at traffic speeds between locations.

***For Utility Operations Use: "UTILITY WORK AHEAD"**

Shoulder Work With Minor Encroachment



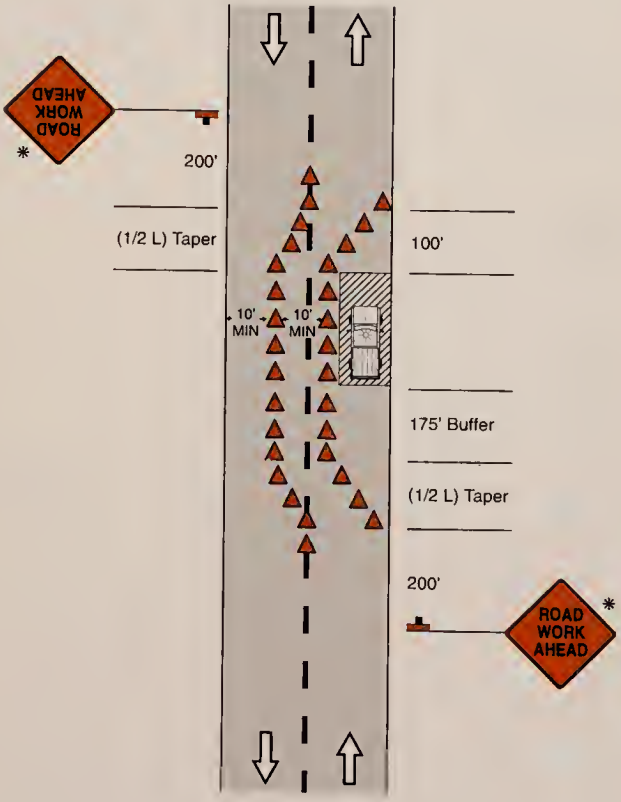
NOTES:

1. The treatment shown may be used on a minor road having low speeds. For higher speed traffic conditions, a lane closure should be considered.
2. The procedure shown should be adequate to carry bi-directional traffic at reduced speed through the activity area, provided the lanes are at least ten feet wide.
3. Where the opposite shoulder is suitable for carrying traffic and of adequate width, traffic lanes may be shifted by use of closely spaced channelizing devices, provided ten-foot wide lanes are maintained.
4. Additional advance warning may be appropriate, such as a ROAD NARROWS sign.
5. Portable concrete barriers may be used along the work space.
6. The protection vehicle is optional if taper and channelizing devices are used. For short-duration work, the taper and channelizing devices are optional if the protection vehicle with an activated flashing yellow light is used.

*For Utility Operations Use: "UTILITY WORK AHEAD"

Work in Travel Lane on Minor Urban Street

(Maintaining Two-Way Traffic)

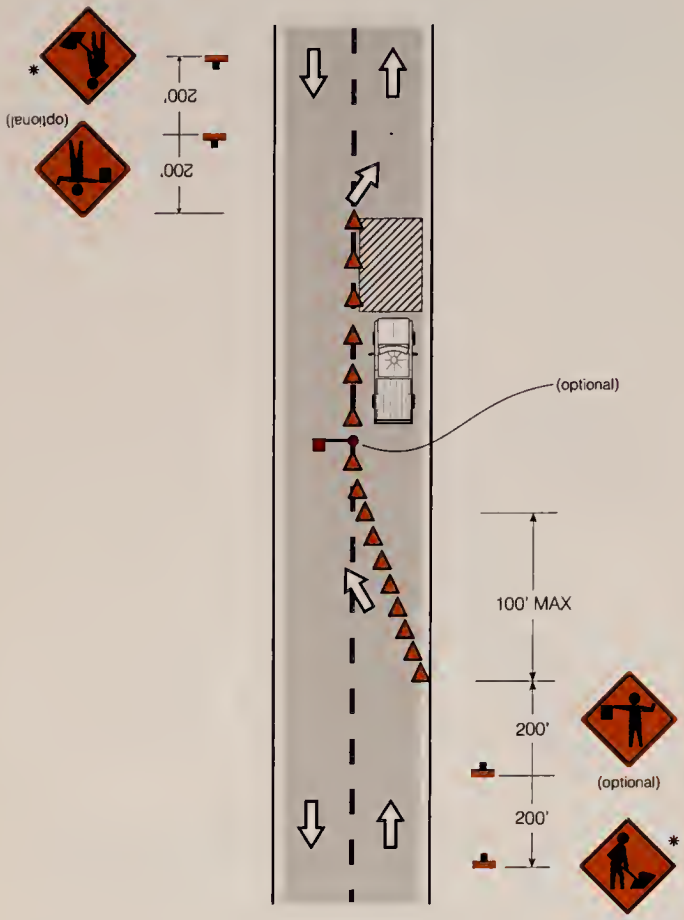


NOTES:

1. This layout is only appropriate for low volume, low speed (35 MPH or less) urban streets.
2. A minimum lane width of 10 feet should be provided in both directions. (The lane width should not extend beyond the edge of pavement.)
3. Additional advance warning may be appropriate, such as "Lane Shifts" and Lane Narrows" signs.

***For Utility Operations Use: "UTILITY WORK AHEAD"**

Lane Closure on Minor Street

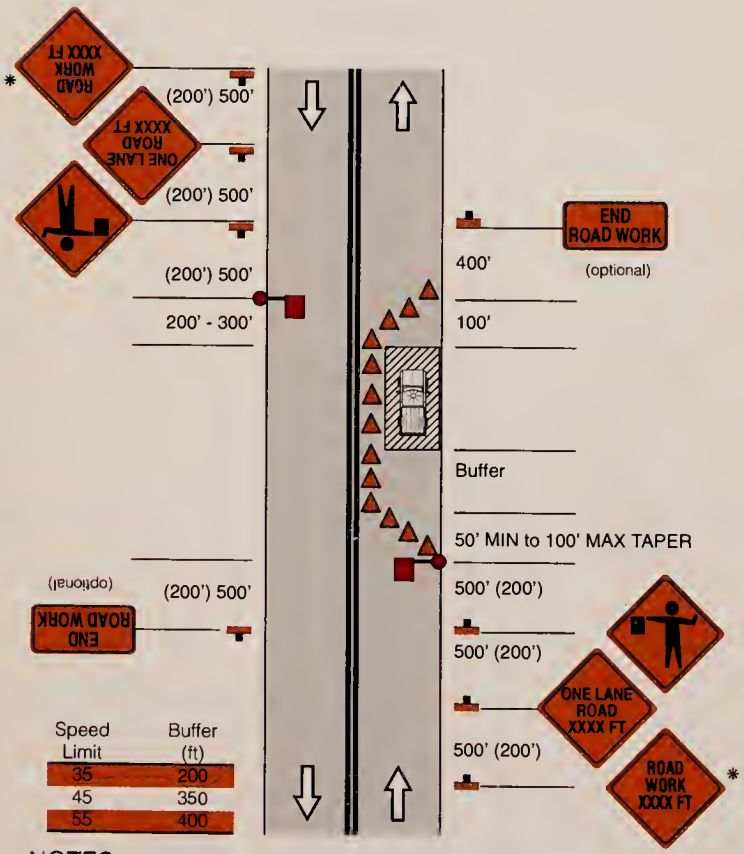


NOTES:

1. The traffic control procedure shown is appropriate only for low-volume, low-speed facilities (35 mph and under), such as local residential streets. With few exceptions, this procedure is not to be used in rural areas.
2. Traffic can regulate itself when volumes are low and the length of the work space is short, thus enabling drivers to readily see the roadway beyond.
3. Flashing warning lights and/or flags may be used to call attention to the advance warning signs.

* **For Utility Operations Use: "UTILITY WORK AHEAD"**

Lane Closure on a Two-Lane Road Using Flaggers



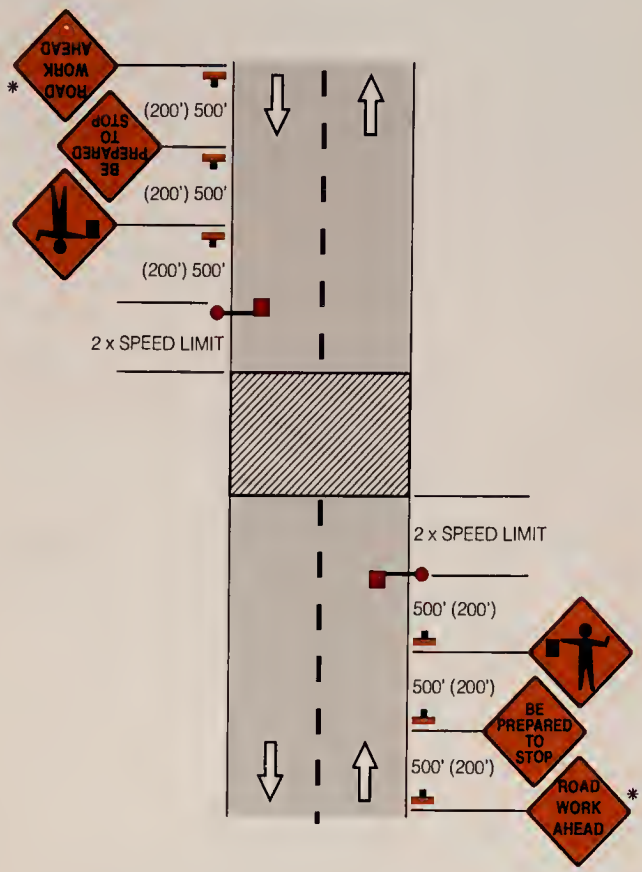
NOTES:

1. Floodlights should be provided to mark flagger stations at night as needed.
2. For low-volume applications, a single flagger may be adequate. Where one flagger can be used, such as for short work areas on straight roadways, the flagger must be visible to approaching traffic from both directions.
3. Channelizing devices are to be extended to a point where they are visible to approaching traffic.
4. The ROAD WORK AHEAD and the END ROAD WORK signs may be omitted for short-duration operations.
5. Flashing warning lights and/or flags may be used to call attention to the advanced warning signs.

*** For Utility Operations, Use: "UTILITY WORK AHEAD"**

Temporary Road Closure

(Not to Exceed 15 - 20 Minutes)

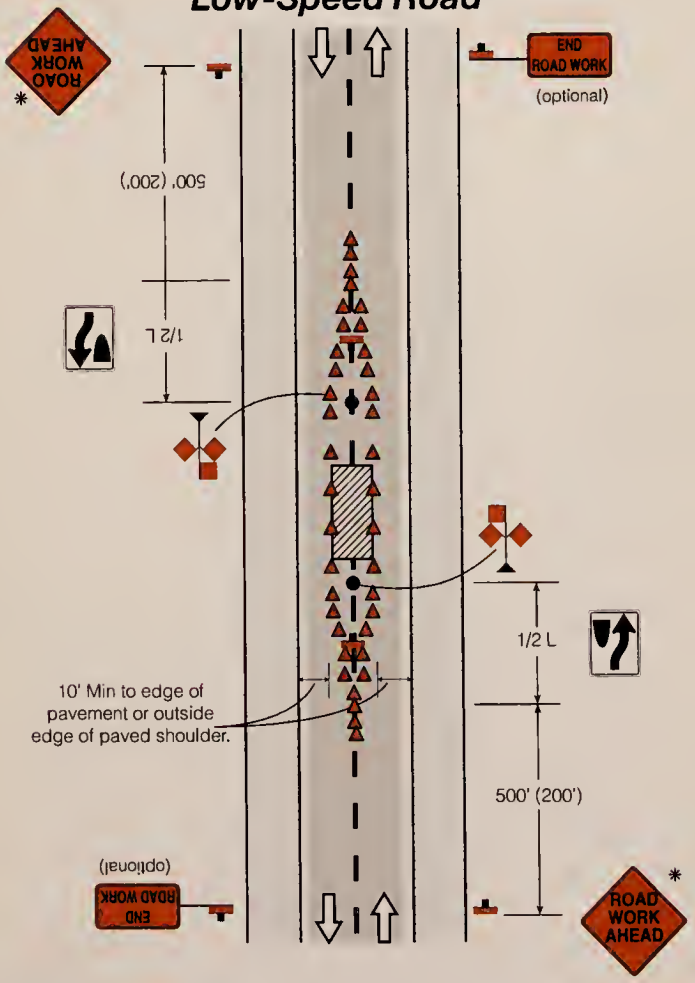


NOTES:

1. Conditions represented are for work which requires closure during daytime hours only.
2. This application is intended for a planned temporary closure not to exceed 15-20 minutes.
3. The flaggers shall stop the first vehicle from the position shown, then move to the centerline to stop approaching traffic.
4. For two-lane, low speed (35 MPH or less) urban streets, a 200-foot sign spacing may be used.

For Utility Operations Use: "UTILITY WORK AHEAD"

Work in Center of Low-Volume, Low-Speed Road

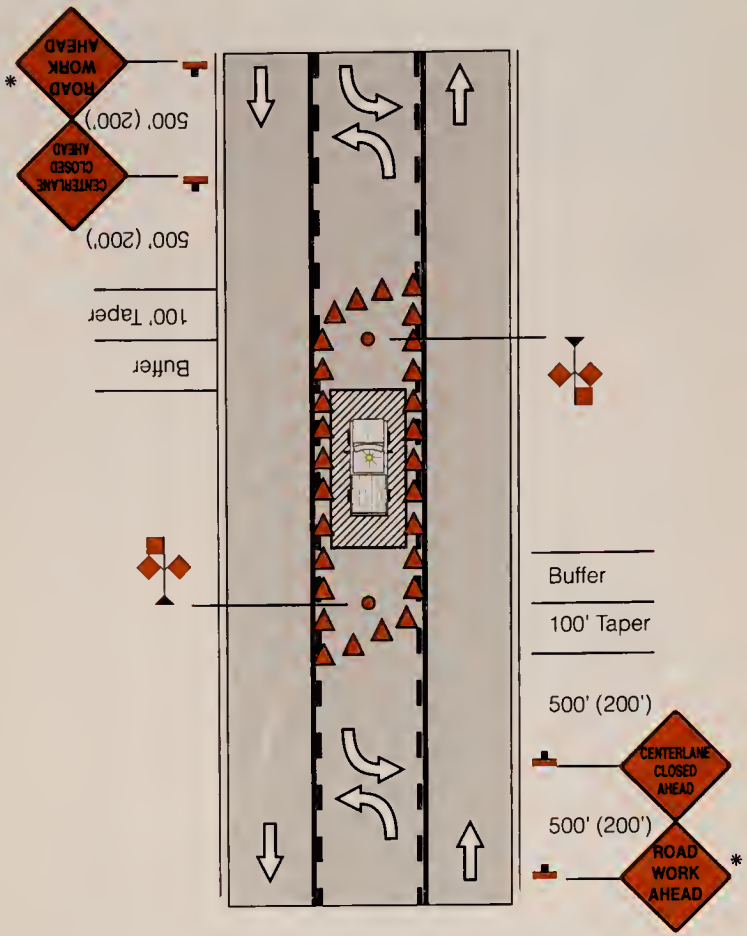


NOTES:

1. The lanes on either side of the center work space should have a minimum width of ten feet, as measured from the near edge of the channelizing devices to the edge of pavement, or the outside edge of paved shoulder.
2. A minimum of six channelizing devices should be used for each taper. However, a work vehicle displaying a flashing or revolving yellow light may be used instead of the tapers.
3. Flashing warning lights and/or flags may be used to call attention to the advanced warning signs.
4. If the closure continues overnight, warning lights may be used to mark channelizing devices.

* For Utility Operations Use: "UTILITY WORK AHEAD"

Center Turn Lane Closed on a Three-Lane, Two-Way Road

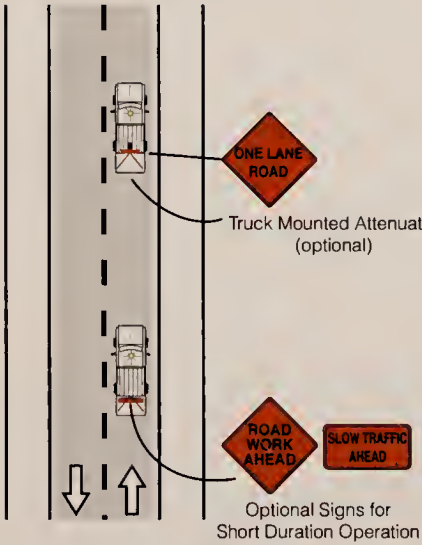


NOTES:

1. For low speed (35 MPH or less) urban streets, a 200-foot sign spacing may be used.
2. High-level warning devices (flag trees or flashing arrow panels) may be used for added visibility.

For Utility Operations Use: "UTILITY WORK AHEAD"

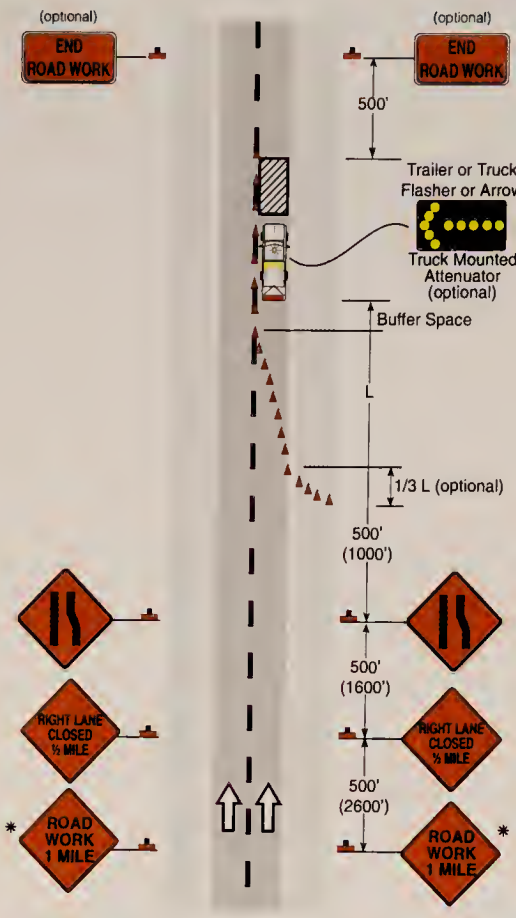
Mobile Operations on a Two-Lane Road



NOTES:

1. Where practicable and when needed, the work and protection vehicles should pull over periodically to allow traffic to pass. If this cannot be done frequently, as an alternative, a DO NOT PASS sign may be placed on the rear of the vehicle blocking the lane.
2. The distance between the work and protection vehicles may vary according to terrain, paint drying time, and other factors. Protection vehicles are used to warn traffic of the operation ahead. Whenever adequate stopping sight distance exists to the rear, the protection vehicle should maintain the minimum distance and proceed at the same speed as the work vehicle. The protection vehicle should slow down in advance of vertical or horizontal curves that restrict sight distance.
3. A truck-mounted attenuator (TMA) shall be used on the protection vehicle and should be considered on the work vehicle.
4. The work vehicle shall be equipped with beacons, and the protection vehicles shall be equipped with a TMA and two high-intensity flashing lights mounted on the rear, adjacent to the sign. Protection and work vehicles should display flashing or rotating beacons both forward and to the rear.
5. Vehicle-mounted signs shall be mounted with the bottom of the sign at a minimum height of four feet above the pavement. Sign legends shall be covered or turned from view when work is not in progress.
6. Arrow displays are optional and should be 60 inches by 30 inches.

Lane Closure on a Divided Highway



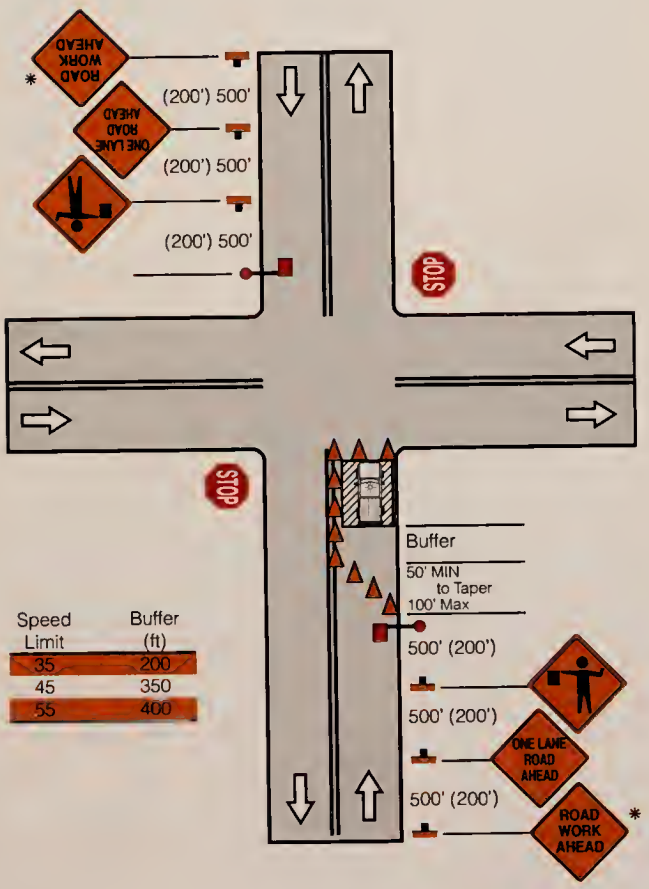
NOTES:

1. For freeways or expressways, consult the MUTCD. Utility companies must obtain approval from the District Traffic Engineer.
2. This procedure also applies when work is being performed in the lane adjacent to the median on a divided highway. Under these conditions, LEFT LAND CLOSED signs and the corresponding LANE REDUCTION symbol signs shall be used.
3. When a side road intersects the highway within the temporary traffic control zone, additional traffic control devices shall be erected, as needed.
4. Longitudinal dimensions may be adjusted slightly to fit field conditions.
5. All vehicles, equipment, workers, and their activities should be restricted to one side of the pavement.

* For Utility Operations Use: "UTILITY WORK AHEAD" (For interstate operations)

Lane Closure in Advance of Intersection

(Stop Signs on East/West Approaches)



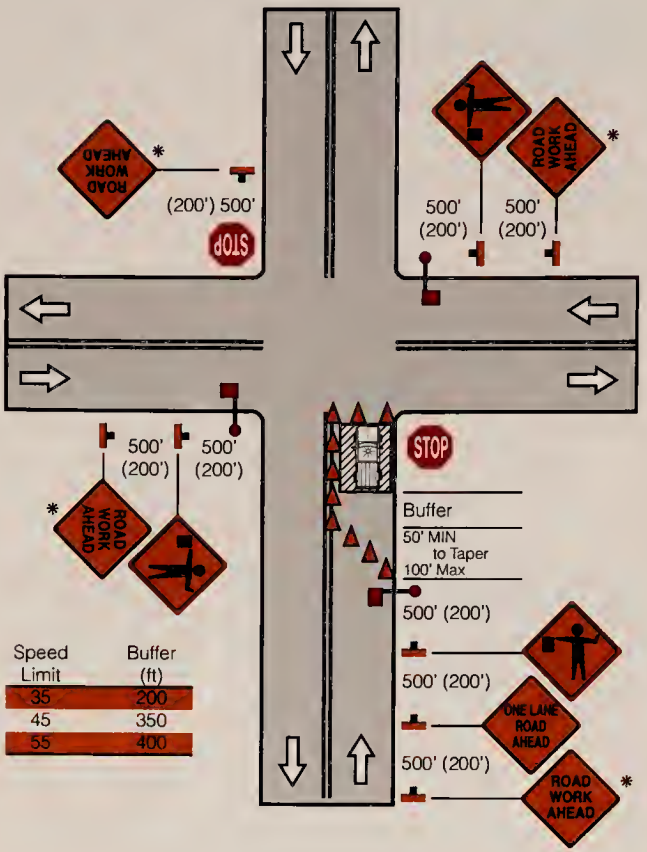
NOTES:

1. Depending on traffic conditions, additional traffic control such as flaggers and appropriate signage may be needed on the cross road approaches.
2. For two-lane, low speed (35 mph or less) urban streets, a 200-foot sign spacing may be used.
3. On high speed or high volume roadways, additional flaggers should be used.

*** For Utility Operations Use: "UTILITY WORK AHEAD"**

Lane Closure in Advance of Intersection

(Stop Signs on North/South Approaches)



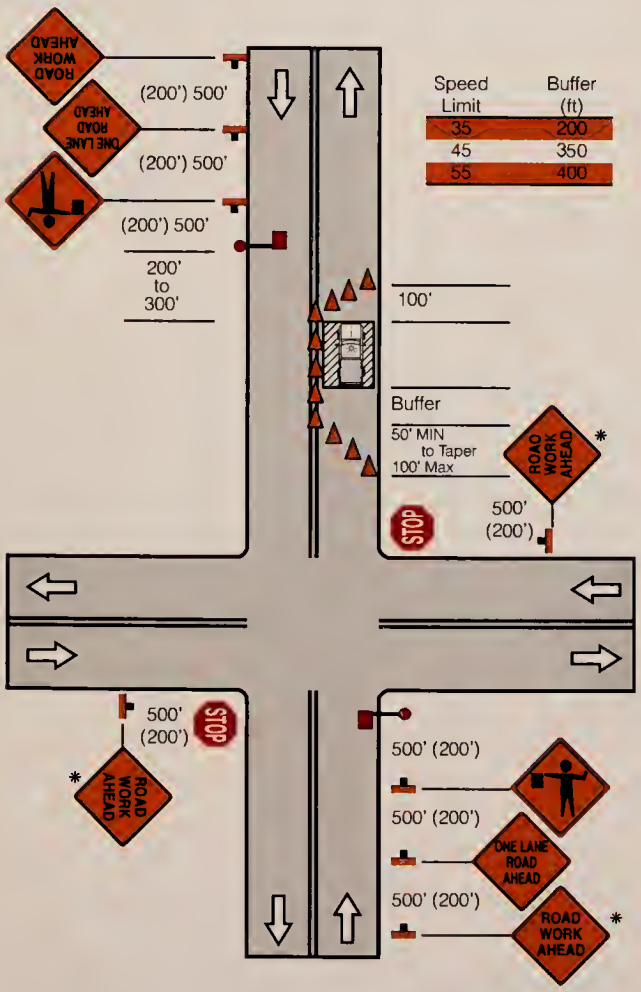
NOTES:

1. Depending on traffic conditions, additional traffic control such as flaggers and appropriate signage may be needed on the cross road approaches.
2. For two-lane, low speed (35 mph or less) urban streets, a 200-foot sign spacing may be used.

*** For Utility Operations Use: "UTILITY WORK AHEAD"**

Lane Closure Beyond Intersection

(Stop Signs on East/West Approaches)



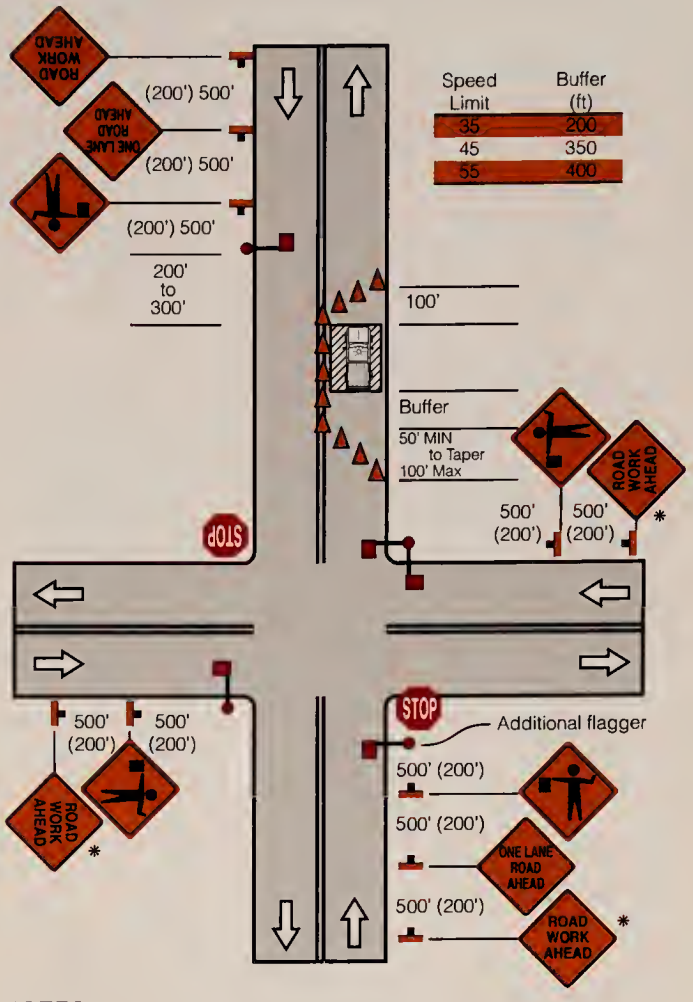
NOTES:

1. Depending on traffic conditions, additional traffic control such as flaggers and appropriate signage may be needed on the cross road approaches.
2. For two-lane, low speed (35 mph or less) urban streets, a 200-foot sign spacing may be used.
3. On high speed or high volume roadways, two additional flaggers should be used.

*** For Utility Operations Use: "UTILITY WORK AHEAD"**

Lane Closure Beyond Intersection

(Stop Signs on North/South Approaches)

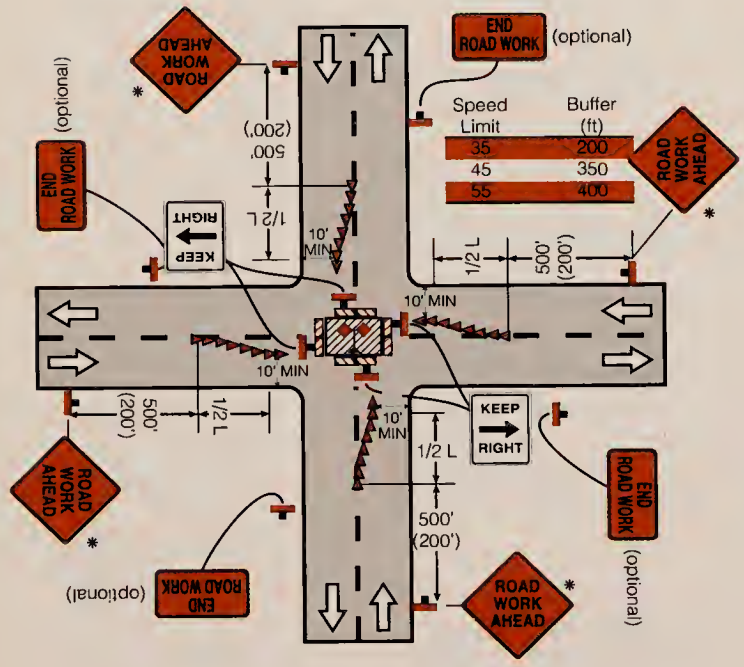


NOTES:

1. Depending on traffic conditions, additional traffic control such as flaggers and appropriate signage may be needed on the cross road approaches.
2. For two-lane, low speed (35 mph or less) urban streets, a 200-foot sign spacing may be used.
3. On high speed or high volume roadways, one additional flagger should be used.

*** For Utility Operations Use: "UTILITY WORK AHEAD"**

Closure in Center of Intersection



NOTES:

1. Prohibit left turns as required by traffic conditions. Unless the streets are wide, it may be physically impossible to turn left, especially for large vehicles.
2. A minimum of six channelizing devices shall be used for each taper.
3. For operations 15 minutes or less in duration, the channelizing devices may be eliminated if a flashing or revolving yellow light is displayed in the work space.
4. A high-level flag tree or flashing arrow panels should be placed in the work space if there is sufficient room.
5. Flashing warning lights and/or flags may be used to call attention to advanced warning signs.

*** For Utility Operations Use: "UTILITY WORK AHEAD"**

Flagging Procedures



To
Stop Traffic



Traffic
Proceed



To
Alert and
Slow Traffic

Properly Trained Flaggers

- clear message to drivers as shown
- allows distance for drivers to react
- coordinate with other flaggers

Properly Equipped Flaggers

- approved sign paddles
- approved safety vest
- reflective night equipment
- approved hard hat

Proper Flagging Stations

- good approach sight distance
- highly visible to traffic
- never stand in moving traffic lane

Proper Advance Warning Signs

- always use warning signs
- allow reaction distance from signs
- remove signs if not flagging

Liability

Steps to Minimize Liability:

- have a traffic control plan approved by the District Traffic Engineer
- follow the MUTCD *(Manual on Uniform Traffic Control Devices)*
- minimize traffic disruptions
- promptly remove devices, beginning with furthermost traffic control device
- train all personnel
- use legible and clean traffic control devices
- inspect work zone sites periodically for conformance
- keep equipment not in use away from the work site

Elements of a Good Inspection Program:

- routine schedule
- report form
- hazard identification
- adequate personnel and inventory
- repair verification
- formal documentation

Minimum Documentation:

- starting and ending time of work
- location of work
- type, condition and position of traffic control devices
- names of personnel
- type of equipment used
- any change in temporary or permanent regulatory devices
- additional information should be gathered in the event of an accident

Supervisor's Checklist

1. Follow Part VI of the *Manual on Uniform Traffic Control Devices* (MUTCD). It is the national standard for work zone traffic control.
2. MDT manuals should be used to supplement the MUTCD.
3. Have a plan approved before going to the work site.
4. Remove the devices in a timely manner.
5. Ask yourself, "What is the driver's view?"
6. Is ALL equipment and material not in use at least 30' from shoulder of the highway or does it meet clear zone requirements?
7. Are trenches or pushing pits located within 30' of the roadway shoulder or within clear zone, protected by appropriate traffic control devices?

Acknowledgments

These guidelines were developed by the North Carolina League of Municipalities and the North Carolina Governor's Highway Safety Program. The guidelines have been modified to meet MDT procedures by the MDT Utilities Section.

Contact the Nearest District office for assistance in traffic control planning.

DIVISION 1
Montana Department of Transportation
2100 West Broadway
P.O. Box 7039
Missoula, MT 59807-7039 Tel: (406)549-6491

DIVISION 2
Montana Department of Transportation
Wynne & Lowell
P.O. Box 3068
Butte, MT 59702-3068 Tel: (406)494-3224
Bozeman Office Tel: (406)586-9562

DIVISION 3
Montana Department of Transportation
104 - 18th Avenue NE
P.O. Box 1359
Great Falls, MT 59403 Tel: (406)727-4350

DIVISION 4
Montana Department of Transportation
503 North River Avenue
P.O. Box 890
Glendive, MT 59330-0890 Tel: (406)365-5296

DIVISION 5
Montana Department of Transportation
424 Morey
P.O. Box 20437
Billings, MT 59104-0437 Tel: (406)252-4138

Other Contacts

HELENA HEADQUARTERS
Montana Department of Transportation
R/W Bureau-Utilities Section
2701 Prospect Avenue
Helena, MT 59620-1001 Tel: (406)444-6080

LTAP
Local Technical Assistance Program
Department of Civil Engineering
Cobleigh Hall • Room 202
Montana State University
Bozeman, MT 59717-0390 Tel: (800)541-6671

MDT Library
3 9526 01022828 5



Montana Local Technical Assistance Program

Department of Civil Engineering
Cobleigh Hall ◆ Room 202
Montana State University
Bozeman, MT 59717-0390
1-800-541-6671